Method and Apparatus for Processing Shared Sub-packets in a Communication System

BACKGROUND

Field

[1001]   The present invention relates generally to communication systems, and more specifically to a method and an apparatus for processing shared sub-packets in a communication system.

Background

[1002]   Communication systems have been developed to allow transmission of information signals from an origination station to a physically distinct destination station. In transmitting information signal from the origination station over a communication channel, the information signal is first converted into a form suitable for efficient transmission over the communication channel. Conversion, or modulation, of the information signal involves varying a parameter of a carrier wave in accordance with the information signal in such a way that the spectrum of the resulting modulated carrier is confined within the communication channel bandwidth. At the destination station the original information signal is replicated from the modulated carrier wave received over the communication channel. Such a replication is generally achieved by using an inverse of the modulation process employed by the origination station.

[1003]   Modulation also facilitates multiple-access, i.e., simultaneous transmission and/or reception, of several signals over a common communication channel. Multiple-access communication systems often include a plurality of remote subscriber units requiring intermittent service of relatively short duration rather than continuous access to the common communication channel. Several

multiple-access techniques are known in the art, such as time division multiple-access (TDMA), frequency division multiple-access (FDMA), and amplitude modulation multiple-access (AM). Another type of a multiple-access technique is a code division multiple-access (CDMA) spread spectrum system that conforms to the "TIA/EIA/IS-95 Mobile Station-Base Station Compatibility Standard for Dual-Mode Wide-Band Spread Spectrum Cellular System," hereinafter referred to as the TIA/EIA/IS-95 standard. The use of CDMA techniques in a multiple-access communication system is disclosed in U.S. Patent No. 4,901,307, entitled "SPREAD SPECTRUM MULTIPLE-ACCESS COMMUNICATION SYSTEM USING SATELLITE OR TERRESTRIAL REPEATERS," and U.S. Patent No. 5,103,459, entitled "SYSTEM AND METHOD FOR GENERATING WAVEFORMS IN A CDMA CELLULAR TELEPHONE SYSTEM," both assigned to the assignee of the present invention.

[1004]   A multiple-access communication system may be a wireless or wire-line and may carry voice and/or data. An example of a communication system carrying both voice and data is a system in accordance with the TIA/EIA/IS-95 standard, which specifies transmitting voice and data over the communication channel. A method for transmitting data in code channel frames of fixed size is described in detail in U.S. Patent No. 5,504,773, entitled "METHOD AND APPARATUS FOR THE FORMATTING OF DATA FOR TRANSMISSION", assigned to the assignee of the present invention. In accordance with the TIA/EIA/IS-95 standard, the data or voice is partitioned into code channel frames that are 20 milliseconds wide with data rates as high as 14.4 Kbps. Additional examples of a communication systems carrying both voice and data comprise communication systems conforming to the "3rd Generation Partnership Project" (3GPP), embodied in a set of documents including Document Nos. 3G TS 25.211, 3G TS 25.212, 3G TS 25.213, and 3G TS 25.214 (the W-CDMA standard), or "TR-45.5 Physical Layer Standard for cdma2000 Spread Spectrum Systems" (the IS-2000 standard).

[1005]   An example of a data only communication system is a high data rate (HDR) communication system that conforms to the TIA/EIA/TIA/EIA/IS-

895 industry standard, hereinafter referred to as the TIA/EIA/IS-895 standard. This HDR system is based on a communication system disclosed in co-pending application serial number 08/963,386, entitled "METHOD AND APPARATUS FOR HIGH RATE PACKET DATA TRANSMISSION," filed 11/3/1997, assigned to the assignee of the present invention. The HDR communication system defines a set of data rates, ranging from 38.4 kbps to 2.4 Mbps, at which an access point (AP) may send data to a subscriber station (access terminal, AT). Because the AP is analogous to a base station, the terminology with respect to cells and sectors is the same as with respect to voice systems.

[1006] Existing voice/data communication systems generally utilize voice traffic channels for conducting voice telephony or data communications including small file transfer, electronic mail, and facsimile. Consequently, the data transmission rate is limited. For example, in the above-mentioned communication system in accordance with the TIA/EIA/IS-95 standard provides for establishing multiple traffic channels, each having a rate of data up to 14.4 kilobits per second. While 14.4 kilobits per second is adequate for the above-mentioned types of lower data rate applications, the increasing popularity of more data intensive applications such as worldwide web and video conferencing has created a demand for much higher data transmission rates. The communication system in accordance with the TIA/EIA/IS-895 standard satisfies the data rate requirement, but allows for data transmission only. To satisfy the demand for data transmission while retaining voice service capability, several communication systems have been proposed.

[1007] One such a communication system is the above mentioned communication system in accordance with the W-CDMA standard. Another communication system is described in a proposal submitted by LG Electronics, LSI Logic, Lucent Technologies, Nortel Networks, QUALCOMM Incorporated, and Samsung to the 3rd Generation Partnership Project 2 (3GPP2). The proposal is detailed in documents entitled "Updated Joint Physical Layer Proposal for 1xEV-DV," submitted to 3GPP2 as document number C50-20010611-009, June 11, 2001, and "Updated Joint Physical Layer Proposal for 1xEV-DV," file L3NQS_Physical_Layer_v09.doc, August 20, 2001, hereinafter referred to as

1xEV-DV proposal. Yet another communication system is described in a proposal to the 3GPP2 submitted by Motorola, Nokia, Texas Instruments, and LSI Logic. The proposal is detailed in document entitled "1XTREME Physical Layer Specification for Integrated Data and Voice Services in cdma2000 Spread Spectrum Systems," submitted to 3GPP2 as document number C50-20001204-021, December 8, 2000.

[1008]   The 1xEV-DV proposal provides an air interface between a plurality of subscriber stations and a plurality of subscriber stations enabling a simultaneous voice and data services. For that purpose, the 1xEV-DV proposal defines a set of forward and reverse channels.

[1009]   The structure of a reverse channels transmitted by a base stations is illustrated in **FIG. 1**. The reverse Pilot Channel, the Dedicated Control Channel, and the Fundamental Channel remain unchanged. The Supplemental Channel structure remains unchanged for Radio Configurations 1 through 6. The new reverse control channels are the Reverse Rate Indicator Channel (R-RICH), the Reverse Channel Quality Indicator Channel (R-CQICH), and the Reverse Acknowledgment Channel (R-ACKCH).

[1010]   The structure of a forward channels transmitted by a base stations **104(i)** is illustrated in **FIG. 2**. The Forward Pilot Channel, Transmit Diversity Pilot Channel, Auxiliary Pilot Channel, Auxiliary Transmit Diversity Pilot Channel, Synch Channel, Paging Channel, Broadcast Control Channel, Quick Paging Channel, Common Power Control Channel, Common Assignment Channel, Dedicated Control Channel, Forward Fundamental Channel, Forward Supplemental Channel, and Forward Supplemental Code Channels are the same as their counterparts in the above-mentioned IS-2000 standard. The Forward Packet Data Channel, the optional Forward Primary Packet Data Control Channel, and the Forward Secondary Packet Data Control Channel are channels defined for 1xEV-DV packet data operation.

[1011]   The data services are provided to a subscriber station on a Forward Packet Data Channel (F-PDCH), which is shared by packet data users based on time multiplexing. The F-PDCH is composed of a number of code-

division-multiplexed Walsh sub-channels. The number of sub-channels varies in time depending on the demands of the circuit-switched voice and data users. The F-PDCH structure is illustrated in **FIG. 3**. The information bit stream **302** to be transmitted is segmented into packets of several sizes. A 16-bit cyclic redundancy check (CRC) is added to each packet in block **302**, and 6-bit turbo encoder tail allowance is added in block **306** yielding an encoder packet. In one embodiment, the encoder packets are of sizes 384 bits, 768 bits, 1,536 bits, 2,304 bits, 3,072 bits, and 3,840 bits. The encoder packets are encoded by block **308**. Each encoded packet is then scrambled in blocks **310** by a scrambling pattern generated by block **312** and interleaved by block **314**. Some or all of the interleaved symbols are then selected to form sub-packets in block **316**. Depending on the length of the sub-packet, the sub-packet comprises 1, 2, 4, or 8 slots. In one embodiment, the slot is 1.25 ms long. The sub-packet are QPSK, 8-PSK, or 16-QAM modulated by block **318** and demultiplexed into a variable number of pairs (In-phase and Quadrature) of parallel streams by block **320**. Each of the parallel streams is covered with a distinct 32-ary Walsh function by blocks **322(i)**. The Walsh-coded symbols of all the streams are summed together to form a single In-phase stream and a single Quadrature stream by block **324**. The In-phase stream and the Quadrature streams are provided to a block **326**, which adjusts the channel's gain. Several forward link channels, both data and voice are then summed in block **328**, quadtrature spread in block **330**, and the resultant In-phase and Quadrature streams are baseband filtered in block **332(i)**, upconverted in blocks **334(i)** and summed in block **336**.

[1012]   The F-PDCH is controlled by a Forward Primary Packet Data Control Channel (F-PPDCCH) if used and by a Forward Secondary Packet Data Control Channel (F-SPDCCH).

[1013]   The F-PPDCCH is transmitted during the first slot of F-PDCH transmissions, and carries a 2-bit field that indicates the F-PDCH sub-packet length. One of ordinary skills in the art recognizes that because the F-PPDCCH carries only information of the F-PDCH sub-packet length, the use of the F-PPDCCH is optional. The subscriber station may use other means for determining

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the F-PDCH sub-packet length. Thus, for example, the subscriber station may decode the sub-packet for all sub-packet length hypotheses, and select the most likely one of the hypothesis.

[1014]   The F-SPDCCH is transmitted over 1, 2, or 4 slots, and the starts of the F-SPDCCH transmissions are aligned with the starts of the corresponding F-PDCH transmissions. The F-SPDCCH carries bits specifying a medium access control (MAC) identifier (ID), the Automatic Repeat reQuest (ARQ) channel ID, the encoder packet size, and the F-PDCH sub-packet ID.

[1015]   The 1xEV-DV proposal thus allows the base station to send data to multiple mobiles only on a single slot granularity. Furthermore, the highest sub-packet data rate that is allowed for 384-bit packets is 307.2 kbps with one slot per sub-packet. So even when mobiles are capable of receiving higher data rates, they are limited to at most 307.2 kbps and use at least one slot.

[1016]   Similarly, the 1XTREME proposal provides an air interface between a plurality of subscriber stations and a plurality of subscriber stations enabling a simultaneous voice and data services. The 1XTREME proposal uses a fixed sub-packet size of 5 ms for the packet data channels and for the control channels associated with the packet data channels. The packet data sub-packets can be CDM shared, but there is no flexibility on the duration of the data or control sub-packets. The packet data channel is controlled with a dedicated CDM channel for each user, called the Forward Dedicated Pointer Channel, and with a shared control channel, called the Forward Shared Control Channel.

[1017]   The fixed-duration shared packet data sub-packet and limited control of the 1XTREME or 1xEV-DV proposals waste resources and limits the system throughput performance. Consequently, there is a need in the art for a method and an apparatus for improving the throughput of the system by allowing multiple forward-link transmissions per a slot.

SUMMARY

[1018]   In one aspect of the invention, the above-stated needs are addressed by generating a first control channel comprising an indicator that a traffic channel is to be shared and a parameters of a traffic channels; and generating at least one second control channel, each of said at least one second control channel comprising an identity of at least one subscriber station and information enabling the subscriber station to demodulate the traffic channel.

[1019]   In another aspect of the invention, the above-stated needs are addressed by demodulating a first control channel to determine whether a traffic channel is to be shared; determining a number of subscriber stations sharing a traffic channel and multiplexing of the traffic channel in accordance with said demodulated control channel if the traffic channel is to be shared; demodulating a second control channel comprising identity of a subscriber station, and information enabling a subscriber station to demodulate a traffic channel; and demodulating the traffic channel in accordance with said determined multiplexing and the enabling information if the acquired identity is identical to an identity of the subscriber station.

BRIEF DESCRIPTION OF THE DRAWINGS

[1020]   FIG.1 illustrates a structure of a reverse channels transmitted by a base stations;

[1021]   FIG. 2 illustrates a structure of a reverse channels transmitted by a base stations;

[1022]   FIG. 3 an exemplary forward packet data channel;

[1023]   FIG. 4 illustrates sub-packet structure in accordance with one embodiment;

[1024]   FIG. 5 illustrates sub-packet structure in accordance with one embodiment;

[1025] **FIG. 6** illustrates a control channel structure in accordance with one embodiment;

[1026] **FIG. 7** illustrates a control channel structure in accordance with another embodiment;

[1027] **FIG. 8** illustrates a control channel structure in accordance with another embodiment;

[1028] **FIG. 9** illustrates a CDM channel structure in accordance with one embodiment;

[1029] **FIG. 10** illustrates a control channel structure in accordance with another embodiment;

[1030] **FIG. 11** illustrates a control channel structure in accordance with another embodiment;

[1031] **FIG. 12** illustrates a control channel structure in accordance with another embodiment; and

[1032] **FIG. 13** illustrates a control channel structure in accordance with another embodiment.

DETAILED DESCRIPTION
Definitions

[1033] The word "exemplary" is used exclusively herein to mean "serving as an example, instance, or illustration." Any embodiment described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments.

[1034] The term packet is used exclusively herein to mean a group of bits, including data (payload) and control elements, arranged into a specific format. The control elements comprise, e.g., a preamble, a quality metric, and others known to one skilled in the art. Quality metric comprises, e.g., a cyclical redundancy check (CRC), a parity bit, and others known to one skilled in the art.

[1035] The term access network is used exclusively herein to mean a collection of access points (AP) and one or more access point controllers. The

access network transports data packets between multiple access terminals (AT). The access network may be further connected to additional networks outside the access network, such as a corporate intranet or the Internet, and may transport data packets between each access terminal and such outside networks.

[1036]   The term base station, referred to herein as an AP in the case of an HDR communication system, is used exclusively herein to mean the hardware with which subscriber stations communicate. Cell refers to the hardware or a geographic coverage area, depending on the context in which the term is used. A sector is a partition of a cell. Because a sector has the attributes of a cell, the teachings described in terms of cells are readily extended to sectors.

[1037]   The term subscriber station, referred to herein as an AT in the case of an HDR communication system, is used exclusively herein to mean the hardware with which an access network communicates. An AT may be mobile or stationary. An AT may be any data device that communicates through a wireless channel or through a wired channel, for example using fiber optic or coaxial cables. An AT may further be any of a number of types of devices including but not limited to PC card, compact flash, external or internal modem, or wireless or wireline phone. An AT that is in the process of establishing an active traffic channel connection with an AP is said to be in a connection setup state. An AT that has established an active traffic channel connection with an AP is called an active AT, and is said to be in a traffic state.

[1038]   The term communication channel/link is used exclusively herein to mean a single route over which a signal is transmitted described in terms of modulation characteristics and coding, or a single route within the protocol layers of either the AP or the AT.

[1039]   The term reverse channel/link is used exclusively herein to mean a communication channel/link through which the AT sends signals to the AP.

[1040]   A forward channel/link is used exclusively herein to mean a communication channel/link through which an AP sends signals to an AT.

[1041]   The term soft hand-off is used exclusively herein to mean a communication between a subscriber station and two or more sectors, wherein

each sector belongs to a different cell. In the context of TIA/EIA/IS-95 standard, the reverse link communication is received by both sectors, and the forward link communication is simultaneously carried on the two or more sectors' forward links. In the context of the TIA/EIA/IS-895 standard, data transmission on the forward link is non-simultaneously carried out between one of the two or more sectors and the AT.

[1042] The term softer hand-off is used exclusively herein to mean a communication between a subscriber station and two or more sectors, wherein each sector belongs to the same cell. In the context of the TIA/EIA/IS-95 standard, the reverse link communication is received by both sectors, and the forward link communication is simultaneously carried on one of the two or more sectors' forward links. In the context of the TIA/EIA/IS-895 standard, data transmission on the forward link is non-simultaneously carried out between one of the two or more sectors and the AT.

[1043] The term re-pointing is used exclusively herein to mean a selection of a sector that is a member of an ATs' active list, wherein the sector is different than a currently selected sector.

[1044] The term soft/softer hand-off delay is used exclusively herein to indicate the minimum interruption in service that a subscriber station would experience following a handoff to another sector. Soft/Softer handoff delay is determined based on whether the sector, (currently not serving the subscriber station), (non-serving sector) to which the subscriber station is re-pointing is part of the same cell as the current serving sector. If the non-serving sector is in the same cell as the serving sector then the softer handoff delay is used, and if the non-serving sector is in a cell different from the one that the serving sector is part of then the soft-handoff delay is used.

[1045] The term non-homogenous soft/softer hand-off delay is used exclusively herein to indicate that the soft/softer hand-off delays are sector specific and therefore may not uniform across the sectors of an Access Network.

[1046]   The term credit is used exclusively herein to mean a dimensionless attribute indicating a quality metric of a reverse link, a quality metric of a forward link, or a composite quality metric of both forward and reverse links.

[1047]   The term erasure is used exclusively herein to mean failure to recognize a message.

[1048]   The term outage is used exclusively herein to mean a time interval during which the likelihood that a subscriber station will receive service is reduced.

[1049]   The term fixed rate mode is used exclusively herein to mean that a particular sector transmits a Forward Traffic Channel to the AT at one particular rate.

Description

[1050]   The present invention utilizes the sub-packet structure as defined in the 1xEV-DV proposal, but further divides the sub-packet granularity. Throughout the following description, the channels are discussed in terms of structure required for understanding the concept of the invention. Consequently, one of ordinary skills in the art appreciates that the channel structure may contain additional elements required for transmission, e.g., CRC, encoder tail bits, and other blocks known to one of ordinary skills in the art.

[1051]   **FIG. 4** illustrates sub-packet structure in accordance with one embodiment. The sub-packet **400** comprises one or more slots **402(i)**. Each of the slots **402(i)** is further time-divided into sub-slots **404(i)**. (Only one slot sub-division is shown.)   In one embodiment, there are 2, 4 or 8 equal sub-slots **404(i)**. However, one skilled in the art understands that the sub division is an implementation choice and other sub-divisions are within the scope of the invention. The data to a subscriber station are provided in one or more of the sub-slots **404(i)**. Each subscriber station can use a number of sub-slots **404(i)**, and the number of sub-slots for each of the subscriber station utilizing each of the sub-packets **402(i)** can be different.

[1052]   In accordance with another embodiment, illustrated in **FIG. 5**, the slot(s) **502(i)** of the sub-packet **500** contain data for several subscriber stations. Data from all the slots **502(i)** of the sub-packet **500** for a particular mobile are sent using one or more of the available Walsh channels. As illustrated in **FIG. 5**, slots **402(1)-402(n)** contain data encoded by Walsh codes **504(1)-504(m)**, therefore, carry data for m subscriber stations. Consequently, the number of subscriber stations receiving information concurrently may be changed on a sub-packet to sub-packet basis.

Control Structures

[1053]   Due to the variability of the structure of the F-PDCH as described above, a subscriber station must be provided with information enabling the subscriber station to demodulate the F-PDCH. In one embodiment utilizing the code-division of the sub-packets, the existing structures of the F-PPDCCH and the F-SPDCCH can be utilized. One skilled in the art appreciates that although the following description describes modifications of the F-PPDCCH and the F-SPDCCH, this is for tutorial purposes only, and new channels in accordance with the described embodiments can be defined. Additional information is carried on one or more new channels.

[1054]   **FIG. 6** illustrates a control channel structure in accordance with one embodiment, comprising the F-PPDCCH **600**, the F-SPDCCH **602**, and one CDM control channel **608(i)** for each of the subscriber stations sharing the sub-packet. The F-PPDCCH **600** is utilized as defined in the 1xEV-DV proposal. One of ordinary skills in the art recognizes that because the F-PPDCCH carries only information about the F-PDCH sub-packet length, the use of the F-PPDCCH is optional. The subscriber station may use other means for determining the F-PDCH sub-packet length. Thus, for example, the subscriber station may decode the sub-packet for all sub-packet length hypotheses, and select the most likely one of the hypothesis.

[1055]   Similarly, the F-SPDCCH **602** is utilized as defined in the 1xEV-DV proposal with the following modification. One of the values of the MAC ID of block **604** is reserved to identify that a sub-packet of the F-PDCH is to be shared. In accordance with one embodiment, the MAC ID value identifies that the sub-packet is to be shared is all ones. Because all the subscriber stations for which the shared sub-packets are intended must reliably receive the information content of channel **602**, channel **602** is transmitted at power determined by the power requirement of the subscriber station, for which the control channel **602** is intended, with the worst forward link quality metric. Upon receiving the channel **602,** each of the subscriber stations demodulates and decodes the MAC ID of block **604**. If the MAC ID indicates that the sub-packet is for one of the subscriber stations, the identified subscriber station processes the sub-packet in accordance with the procedures outlined in the 1xEV-DV proposal.

[1056]   If the MAC ID indicates that the sub-packet is to be shared, the remaining bits of block **606** are interpreted to indicate parameters of the shared sub-packet. The parameters comprise a number of subscriber stations sharing the sub-packet. Consequently, each of the subscriber stations acquires this information, and then starts receiving the CDM channels **608(i).** Because each of the CDM channels **608(i)** is modulated by a Walsh code, the subscriber stations need to know these Walsh codes. In one embodiment, pre-determined Walsh codes are reserved for the CDM channels **608(i).** In another embodiment, the subscriber stations are notified about the Walsh codes by signaling messages. Only the number of CDM channels **608(i)** equal to the number of subscriber stations sharing the sub-packet is transmitted, and the transmission occurs only when the sub-packet is shared. In one embodiment, the CDM channels **608(i)** are transmitted concurrently, consequently, each of the subscriber stations accumulates data from all the CDM channels **608(i)**, and then post processes the accumulated data. Because each of the CDM channels **608(i)** is intended for one of the subscriber stations and the base station has an information about the subscriber station forward link quality metric, the base station transmits each of the

CDM channels **608(i)** at the minimum power determined by power requirement of the subscriber station.

[1057]   Each of the CDM channels **608(i)** comprises information enabling the subscriber station to determine which of the CDM channels **608(i)** is intended for the subscriber station and information enabling the subscriber station to demodulate the F-PDCH. The information enabling the subscriber station to determine which of the CDM channels **608(i)** is intended for the subscriber station comprises a MAC ID **610(i)**. The information enabling the subscriber station to demodulate the F-PDCH comprises an ARQ ID **612(i)**, a sub-packet ID **616(i)**, a packet size **618(i)**, and a number of Walsh channels used **620(i)**. In one embodiment, the current F-PDCCH coding and modulation is used for each of the CDM channels **608(i)**. During the post processing, each of the subscriber stations demodulates the MAC ID **610(i)** of a CDM channel **608(i)**. If the MAC ID **610(i)** indicates that the CDM channel **608(i)** does not contain information for the subscriber station, the subscriber station ceases further post processing of the channel and repeats the procedure for the next CDM channel **608(i+1)**. If a subscriber demodulates a MAC ID **610(i)** indicating that the CDM channel **608(i)** contains information for the subscriber station, the subscriber station demodulates the remaining information, and processes the sub-packet on the F-PDCH in accordance to the gathered information.

[1058]   In another embodiment utilizing the code-division of the sub-packets, the information is provided on the F-PPDCCH, the F-SPDCCH, and one CDM channel for all the subscriber stations sharing the sub-packet. Consequently, the F-PPDCCH and the F-SPDCCH have the structure as described with reference to **FIG. 6**. The structure of the CDM channel carries the information enabling each of the subscriber stations to demodulate the F-PDCH. The information for all the subscriber stations is time multiplexed and then encoded and modulated. Consequently, the CDM channel comprises concatenation of the CDM channels **608(i)** as described in **FIG. 6**. In one embodiment, the current F-SPDCCH coding and modulation is used for the CDM channel. Consequently, the method of acquiring the information is the same as described above, with the exception that

all the subscriber stations demodulate and decode the whole information carried on the CDM channel. The subscriber station then examines the MAC IDs. If the subscriber station fails to find a MAC ID indicating that the subscriber station is to share the sub-packet, the subscriber station ceases further processing. If a subscriber finds a MAC ID indicating that the following portion of the CDM channel contains information for the subscriber station, the subscriber station demodulates the information, and processes the sub-packet on the F-PDCH in accordance with the gathered information.

[1059]   One of ordinary skill in the art appreciates that limiting number of subscriber station sharing the sub-packet yields further simplification of the above-described embodiments. Consequently, in one embodiment allowing only two subscriber station to share the sub-packet, the existing structure of the F-PPDCCH and a modified structure of the F-SPDCCH can be utilized. Thus, there is no need for an additional control channel.

[1060]   The F-PPDCCH is utilized as defined in the 1xEV-DV proposal. One of ordinary skills in the art recognizes that because the F-PPDCCH carries only information about the F-PDCH sub-packet length, the use of the F-PPDCCH is optional. The subscriber station may use other means for determining the F-PDCH sub-packet length. Thus, for example, the subscriber station may decode the sub-packet for all sub-packet length hypotheses, and select the most likely one of the hypothesis.

[1061]   FIG. 7 illustrates a structure of the modified F-SPDCCH **700**. The modified F-SPDCCH **700** comprises information enabling the two subscriber stations to demodulate the F-PDCH. Therefore, the F-SPDCCH **700** comprises and MAC IDs for each subscriber stations **702(1)**, **702(2)**, ARQ IDs **702(1)**, **704(2)**, sub-packet IDs **706(1)**, **706(2)**, encoder packet sizes **708(1)**, **708(2)**, and number of Walsh channels used **710(1)**, **710(2)**. The structure can be further simplified if the second subscriber station is assumed to use a number of Walsh channels less than or equal to the number of Walsh channels of the second subscriber station. Then the modified F-SPDCCH **700** comprises only one of the blocks **710(1)**, **710(2)**.

[1062]   Because all the subscriber stations intended to share the sub-packet must reliably receive the modified F-SPDCCH **700**, the modified F-SPDCCH **700** is transmitted at a power determined by the power requirement of the subscriber station with the worst forward link quality metric for which the modified F-SPDCCH **700** is intended.   Upon receiving the modified F-SPDCCH **700**, each of the subscriber stations demodulates the modified F-SPDCCH **700** and decodes the MAC IDs in the blocks **702(1)**, **702(1)**.   If the MAC ID of the subscriber station is identical to either of the decoded MAC IDs, the subscriber station acquires the remaining information from the modified F-SPDCCH **700**, and processes the sub-packet of the F-PDCH in accordance with the information.

[1063]   The modified F-SPDCCH **700** is transmitted even if the F-PDCH is intended for only one subscriber station. In this case, the MAC ID **702(2)**, is identical to the **MAC ID 702(1)**. Consequently, the subscriber stations ignore the interpretation of block **704(2)** as ARQ ID, **706(2)** as sub-packet ID, **708(2)** as encoder packet size, and **710(2)** as number of Walsh channels used **710(1)**.   Consequently, these blocks can be used for any additional information.   The subscriber a MAC ID of which is identical to the decoded MAC ID acquires the remaining information from the modified F-SPDCCH **700**, and processes the sub-packet of the F-PDCH in accordance with procedures outlined in the 1xEV-DV proposal.

[1064]   In accordance with another embodiment, the existing structures of the F-PPDCCH and the F-SPDCCH can be utilized. The F-PPDCCH is utilized as defined in the 1xEV-DV proposal. One of ordinary skills in the art recognizes that because the F-PPDCCH carries only information about the F-PDCH sub-packet length, the use of the F-PPDCCH is optional. The subscriber station may use other means for determining the F-PDCH sub-packet length. Thus, for example, the subscriber station may decode the sub-packet for all sub-packet length hypotheses, and select the most likely one of the hypothesis. The F-SPDCCH comprises information enabling one of the two subscriber stations to demodulate the F-PDCH and an indicator to specify whether another CDM control

channel is transmitted. The CDM control channel comprises information enabling one subscriber station to demodulate the F-PDCH.

[1065]   FIG. 8 illustrates a control channel structure the F-SPDCCH 800, and the CDM control channel 802. The F-SPDCCH 800 comprises an MAC ID 804, ARQ ID 806, sub-packet ID 808, encoder packet size 810, and numbers of Walsh channels used 812 for one of the possible two shared channels, and the a CDM indicator 814.

[1066]   The CDM channel 802 comprises an MAC ID 816, ARQ ID 818, sub-packet ID 820, encoder packet size 822, and number of Walsh channels used 824 for the second shared channel if it is used. If the F-PDCH sub-packet is not shared, the CDM channel 802 is not transmitted for that sub-packet

[1067]   In one embodiment, the F-SPDCCH 800 and, if used, the CDM control channel 802 are transmitted concurrently. Because the subscriber stations do not know, whether the CDM control channel 802 is transmitted or not, each of the subscriber stations accumulates data from both the F-SPDCCH 800 and all the CDM channel 802, and then post processes the accumulated data. Because both subscriber stations to share the sub-packet must reliably receive the F-SPDCCH 800, the F-SPDCCH 800 is transmitted at a power determined by power requirement of the subscriber station with the worst forward link quality metric fro which the F-SPDCCH 800 is intended. Because the CDM control channel 802 is intended for one of the subscriber stations and the base station has an information about the subscriber station's forward link quality metric, the base station transmits the CDM control channel 802 at the minimum power determined by power requirement of the subscriber station.

[1068]   Upon receiving the modified F-SPDCCH 800, each of the subscriber stations decodes the MAC ID 802. If the decoded MAC ID is identical to the subscriber station's MAC ID, the subscriber station decodes the remaining information from the F-SPDCCH 800, and processes the sub-packet of the F-PDCH in accordance with the information.

[1069]   The subscriber stations, MAC IDs of which are not identical with the decoded MAC ID, decode the CDM indicator 814. If the CDM indicator

X214 indicates that no CDM control channel **802** is transmitted, the subscriber stations cease further processing; otherwise the subscriber stations decode the MAC ID **816**. The subscriber station, a MAC ID of which is identical with the decoded MAC ID acquires the remaining information from the CDM control channel **802**, and processes the sub-packet of the F-PDCH in accordance with the information. The subscriber stations, MAC IDs of which are not identical with the decoded MAC ID cease further processing.

[1070]   In another embodiment utilizing the time-division of the F-PDCH sub-packets, the control information is provided on the F-PPDCCH, the F-SPDCCH, and one CDM channel for each of the subscriber stations sharing the sub-packet.

[1071]   The function and the structure of the F-PPDCCH is identical to the function and the structure of the F-PPDCCH as described above with regards to the CDM based F-PDCH sub-packet sharing.

[1072]   Similarly, the function and the structure of the F-PSDCCH is identical to the function and the structure of the F-PSDCCH as described above with regards to the CDM based sub-packet sharing with the following modification. If the MAC ID indicates that a sub-packet of the F-PDCH is to be shared, the remaining bits of the F-SPDCCH are interpreted to indicate parameters of the shared sub-packet, which comprise number of sub-slots into which the sub-packet is subdivided and the number of subscriber stations sharing the sub-packet. Consequently, each of the subscriber stations demodulates the modified F-SPDCCH and decodes the MAC ID. If the MAC ID indicates that the sub-packet is for the subscriber station, the identified subscriber station processes the sub-packet in accordance to procedures outlined in the 1xEV-DV proposal.

[1073]   If the MAC ID indicates that the sub-packet is to be shared, the subscriber stations will use the remaining bits of the F-SPDCCH to determine the number of sub-slots into which the sub-packet is subdivided and the number of subscriber stations sharing the sub-packet. Consequently, each of the subscriber stations acquires this information, and then starts receiving the TDM channels

900(i), as illustrated in **FIG. 9.** Because each of the CDM channels **900(i)** is modulated by a Walsh code, the subscriber stations need to know these Walsh codes. In one embodiment, pre-determined Walsh codes are reserved for the CDM channels **900(i)**. In another embodiment, the subscriber stations is notified about the Walsh codes by signaling messages. Only the number of CDM channels **900(i)** equal to the number of subscriber stations sharing the sub-packet is transmitted, and the transmission occurs only when the sub-packet is shared. In one embodiment, the CDM channels **900(i)** are transmitted concurrently, consequently, each of the subscriber stations accumulates data from all the TDM channels **900(i)**, and then post processes the accumulated data. Because each of the CDM control channels **900(i)** for the TDM-shared F-PDCH is intended for one of the subscriber stations and the base station has a information about the subscriber station forward link quality metric, the base station transmits each of the CDM control channels **900(i)** at just enough power to reach the intended subscriber station reliably.

[1074]   Each of the CDM control channels **900(i)** comprises information enabling the subscriber station to determine which of the CDM channels **900(i)** is intended for the subscriber station and information enabling the subscriber station to demodulate a F-PDCH. The information enabling the subscriber station to determine which of the CDM channels **900(i)** is intended for the subscriber station comprises a MAC ID **902(i)**. The information enabling the subscriber station to demodulate the F-PDCH comprises an ARQ ID **904(i)**, a sub-packet ID **906(i)**, a format of the shared sub-packet **908(i)**, and a starting sub-slot **910(i)** for each of the mobiles. In one embodiment, the current F-PDCCH coding and modulation is used for each of the CDM channels **900(i)**. During the post processing, each of the subscriber stations demodulates the MAC ID **902(i)** of a control channel **900(i)**. If the MAC ID **902(i)** indicates that the control channel **900(i)** does not contain information for the subscriber station, the subscriber station ceases further post processing of the channel and repeats the procedure for the next control channel **900(i+1)**. If a subscriber demodulates a MAC ID **902(i)** indicating that the control channel **900(i)** contains information for the subscriber

station, the subscriber station reads the remaining information, and processes the sub-packet on the F-PDCH in accordance to the gathered information.

[1075]   In another embodiment utilizing the time-division of the slots, the information is provided on the F-PPDCCH, the F-SPDCCH, and one TDM channel for all the subscriber stations sharing the sub-packet. The TDM channel is modulated by the information enabling each of the subscriber stations to demodulate the F-PDCH. The information for all the subscriber station is time multiplexed and then encoded and modulated. Consequently, the CDM channel comprises concatenation of the CDM channels 900(i) as described in FIG. 9. In one embodiment, the current F-SPDCCH coding and modulation is used for the CDM channel. Consequently, the method of acquiring the information is the same as described above, with the exception that all the subscriber stations tune to the CDM channel, demodulate and decode the whole information. The subscriber station then examines the MAC IDs. If the subscriber station fails to find a MAC ID indicating that the subscriber station is to share the sub-packet, the subscriber station ceases further processing. If a subscriber finds a MAC ID indicating that the following portion of the CDM channel contains information for the subscriber station, the subscriber station reads the rest of the information, and processes the sub-packet on the F-PDCH in accordance to the gathered information. Furthermore, each of the subscriber stations examines each portion of the F-SPDCCH containing the information about sub-slot positions. Consequently, the CDM channel does not need to contain the starting sub-slot for each subscriber station because the subscriber stations have acquired the information on the duration of sub-slots intended for the other subscriber stations.

[1076]   The control channels' structure in accordance with another embodiment is illustrated in FIG. 10. Control channel 1002 comprises an indication of a number of control channels 1008(i) in block 1004. Furthermore, each of blocks 1006(i) identifies a MAC ID of a subscriber station for which information is sent on a F-PDCH. To receive the control channel 1002 the subscriber stations must know modulation parameters of the control channel 1002. In one embodiment, the modulation parameters are pre-determined.   In another embodiment, the

modulation parameters are provided to the subscriber stations by signaling messages. Because all subscriber stations must reliably receive the control channel **1002**, the control channel **1002** is transmitted at power determined by a power requirement of the subscriber station with the worst forward link quality metric. Upon receiving the control channel **1002**, each of the subscriber stations demodulates and decodes the control channel **1002**. Each of the subscriber stations with MAC ID identical to the MAC IDs acquired from block **1006(i)** then acquires one of the control channel **1008(i)**. Consequently, the number of the transmitted control channels **1008(i)** is equal to the number of MAC IDs in the channel **1002**. The subscriber stations with MAC IDs different from the MAC IDs acquired from block **1006(i)** cease further control channel processing.

[1077]   Each of the additional control channels **1008(i)** comprises information enabling a subscriber station identified by one of the MAC IDs to demodulate the F-PDCH. Therefore, in one embodiment, each of the control channels comprises an ARQ channel ID, the encoder packet size, and the F-PDCH sub-packet ID, as well as information for sub-packet TDM/CDM sharing as described above.

[1078]   To acquire information enabling the subscriber station identified by one of the MAC IDs in control channel **1002** to demodulate the F-PDCH, there must exist a relationship between the subscriber station MAC ID and the control channel **1008(i)** comprising the information for the subscriber station. In one embodiment, the relationship is determined by a position of the blocks **1006(i)** within the channel **1002**, and an index of the Walsh code encoding the control channel **1008(i)**. Thus, for example increasing order of MAC ID position in the control channel **1002** means increasing index of the Walsh code encoding the control channel **1008(i)**. The relationship between the control channel's Walsh code and a MAC ID may be pre-determined or changeable by signaling messages. However, one of ordinary skills in the art appreciates that other relationships are within the scope of the invention. Because each of the additional control channel **1008(i)** is intended for one of the subscriber stations and the base station has an information about the subscriber station forward link quality metric, the base station

transmits each of the channels **1008(i)** at the minimum power determined by power requirement of the subscriber station.

[1079]   Once a subscriber station demodulates the appropriate control channel **1008(i)**, the subscriber station decodes the information enabling the demodulation of the F-PDCH, and processes the sub-packet on the F-PDCH in accordance to the gathered information.

[1080]   The control channel(s) structure in accordance with another embodiment is illustrated in **FIG. 11**. Each of the control channels **1102(i)** contains all the information a subscriber station needs to decode the F-PDCH. Therefore, in one embodiment, each of the channels **1102(i)** comprises a MAC ID block **1104**, an ARQ channel ID block **1106**, the encoder packet size block **1108**, and the F-PDCH sub-packet ID block **1110**, as well as information for sub-packet TDM/CDM sharing as described above, collectively identified as block **1112**. Because each of the control channels **1102(i)** is intended for one of the subscriber stations and the base station has an information about the subscriber station forward link quality metric, the base station transmits each of the channels **1108(i)** at the minimum power determined by power requirement of the subscriber station.

[1081]   To receive the control channels **1102(i)** the subscriber stations must know modulation parameters of the control channels **1102(i)**. In one embodiment, the modulation parameters and the number of possible control channels are pre-determined. In one embodiment, the modulation parameters comprise different Walsh codes. Because in accordance with the embodiment, there is no relationship between one subscriber station and one control channel **1102(i)**, the subscriber stations must demodulate all the control channels **1102(i)**. Although a number of transmitted control channels **1102(i)** is equal to a number of subscriber stations for which information is send on a F-PDCH because the number of subscriber stations may change in accordance with the granularity of the F-PDCH as described above, the number of transmitted control channels **1102(i)** changes.

[1082]   In one embodiment, the control channels **1108(i)** are transmitted concurrently, consequently, each of the subscriber stations

accumulates data for all the channels **1108(i)**, and then post processes the accumulated data. During the post processing, each of the subscriber stations demodulates one of the control channels **1102(i)** and decodes a MAC ID of block **1104(i)**. The subscriber station with MAC ID identical to the MAC ID of block **1104(i)** demodulates the remaining information, and processes the sub-packet on the F-PDCH in accordance to the gathered information. If the MAC ID of block **1104(i)** indicates that the channel **1108(i)** does not contain information for the subscriber station, the subscriber station ceases further post processing of the channel and repeats the procedure for the next channel **1108(i)**. Because as discussed, the subscriber station does not have information about the number of transmitted control channels **1108(i)**, unless the subscriber station finds a MAC ID indicating that the channel **1108(i)** contains information for the subscriber station, the subscriber station must attempt to demodulate all possible control channels **1108(i)**.

[1083]   The control channel(s) structure in accordance with another embodiment is illustrated in **FIG. 12**. Each of the control channels **1202(i)** contains all the information a subscriber station needs to decode the F-PDCH. Therefore, in one embodiment, each of the channels **1202(i)** comprises a MAC ID block **1204**, an ARQ channel ID block **1206**, the encoder packet size block **1208**, and the F-PDCH sub-packet ID block **1210**, as well as information for sub-packet TDM/CDM sharing as described above, collectively identified as block **1212**. In addition, one of the control channels **1202(i)**, e.g., control channel **1202(1)** comprises a block **1214**, which identifies number of transmitted control channels **1202(i)**. Because it is desirable that all subscriber stations receive reliably the information content of the control channel **1202(1)**, in one embodiment the control channel **1202(1)** is transmitted at power determined by power requirement of the subscriber station with the worst forward link quality metric. Because each of the control channels **1202(2)-1202(m)** is intended for one of the subscriber stations and the base station has an information about the subscriber station forward link quality metric, the base station transmits each of the channels **1202(2)-1202(m)** at the minimum power determined by power requirement of the subscriber station.

[1084]   To receive the control channels **1202(i)** the subscriber stations must know modulation parameters of the control channels **1202(i)**. In one embodiment, the modulation parameters and the number of possible control channels are pre-determined. Furthermore, there exists a relationship between the control channels **1202(i)** and the modulation parameters. In one embodiment, the modulation parameters comprise different Walsh codes, and the transmitted control channels **1202(i)** are encoded by Walsh codes with sequential indexes. However, one of ordinary skill in the art appreciates that other relationships are within the scope of the invention. Because in accordance with the embodiment, there is no relationship between one subscriber station and one control channel **1202(i)**, the subscriber stations must demodulate all the transmitted control channels **1202(i)**. Although a number of transmitted control channels **1202(i)** is equal to a number of subscriber stations for which information is send on a F-PDCH because the number of subscriber stations may change in accordance with the granularity of the F-PDCH as described above, the number of transmitted control channels **1202(i)** changes.

[1085]   In one embodiment, the channels **1202(i)** are transmitted concurrently, consequently, each of the subscriber stations accumulates data from all the channels **1202(i)**, and then post processes the accumulated data. During the post processing, each of the subscriber stations first demodulates the control channel **1202(1)** and decodes a MAC ID of block **1204**. The subscriber station with MAC ID identical to the MAC ID of block **1204** decodes the remaining information, and processes the sub-packet on the F-PDCH in accordance with the gathered information. The subscriber stations whose MAC IDs are not identical to the MAC ID of block **1204** decode the number of transmitted control channels **1202(i)** of block **1214**, cease further post processing of the control channel **1202(1)**, and repeat the procedure for the next channel **1208(i)**. Therefore, the subscriber stations have information about the number of transmitted control channels **1208(i)**. Because as discussed there exists a relationship between the number of transmitted control channels **1208(i)**, unless the subscriber station finds a MAC ID indicating that the channel **1208(i)** contains information for the subscriber station,

the subscriber station attempts to demodulate only the transmitted channels **1208(i)**.

[1086]   The control channel structure in accordance with another embodiment is identical to the control channel structure as illustrated in **FIG. 12**, with the exception of the relationship between the control channels **1202(i)** and the modulation parameters.   As explained above, it is desirable that all subscriber stations receive reliably the information content of the control channel **1202(1)**, in one embodiment the control channel **1202(1)** is transmitted at power determined by power requirement of the subscriber station with the worst forward link quality metric. Furthermore, each of the control channels **1202(2)-1202(m)** is intended for one of the subscriber stations and the base station has an information about the subscriber station forward link quality metric, consequently, the base station transmits each of the channels **1202(2)-1202(m)** at the minimum power determined by power requirement of the subscriber station. The transmitted control channels **1202(i)** are ordered in accordance with the transmit power, and are modulated by an ordered set of modulation parameters.   In one embodiment, the modulation parameters comprise different Walsh codes, and the control channel **1202(i)** are encoded by Walsh codes with increasing indexes in relation to the increasing transmit power. However, one of ordinary skills in the art appreciates that other relationships are within the scope of the invention.

[1087]   In one embodiment, the channels **1202(i)** are transmitted concurrently, consequently, each of the subscriber stations accumulates data from all the channels **1202(i)**, and then post processes the accumulated data. During the post processing, each of the subscriber stations first demodulates the control channel **1202(1)** and decodes a MAC ID of block **1204**. The subscriber station with MAC ID identical to the MAC ID of block **1204** decodes the remaining information, and processes the sub-packet on the F-PDCH in accordance with the gathered information.

[1088]   The subscriber stations whose MAC IDs are not identical to the MAC ID of block **1204** decode the number of transmitted control channels **1202(i)** of block **1214**, cease further post processing of the control channel

1202(1), and determine the control channel **1202(2)-1202(m)** to be demodulated next. Because of the above-described relationship between the control channel's **1202(i)** power and index of the Walsh code by which the control channel's **1202(i)** is encoded, when a subscriber station attempts to decode one of the control channels **1202(2)-1202(m)** and the decoding fails, then the subscriber station knows that decoding of any of the channels **1202(2)-1202(m)** sent at lower power is likely to fail too. Consequently, the subscriber station next attempts to decode one of the control channels **1202(2)-1202(m)** sent at a higher power. Therefore, one of ordinary skills in the art appreciates that any determination method based on ordered set may be used.

[1089] For example, in accordance with one embodiment, the determination method may utilize binary search method. If the subscriber station experiences the forward link with a good quality metric, the subscriber station demodulates the control channel with the lowest power **1202(m)**, thus encoded by Walsh code with the highest index *m*. If the decoding fails, the subscriber station repeats the process with the control channel with the medium power **1202(m/2)**, thus encoded by Walsh code with the index *m/2*. If the decoding is successful, but the MAC ID indicates that the control channel **1202(m/2)** does not contain information for the subscriber station, the subscriber station repeats the process with a control channel between **1202(m/2)** and **1202(m)**. The method is repeated until the subscriber station exhaust all the control channels between **1202(m/2)** and **1202(m)**, or finds a control channel **1202(i)** with MAC ID indicating that the control channel **1202(i)** is intended for the subscriber station.

[1090] In another embodiment, the subscriber station whose MAC ID is not identical to the MAC ID of block **1204** measure the power of the control channel **1202(i)** from the range **1202(2)-1202(m)**. If the measured power is higher than the power required by the subscriber station, the control channel **1202(i)** containing the information for the subscriber station is likely in the range **1202(i)** – **1202(m)**. The subscriber station can continue measuring the power, using any determination method, e.g., the above-described binary search or select a control channel from the determined range and attempt a demodulation.

[1091]   The control channel structure in accordance with another embodiment is identical to the control channel structure as illustrated in **FIG. 12**, with the exception of the relationship between the control channels **1202(i)** and the modulation parameters.   In accordance with the embodiment, the transmitted control channels **1202(i)** are ordered in accordance with the value of MAC IDs in block **1204**, and are modulated by an ordered set of modulation parameters.   In one embodiment, the modulation parameters comprise different Walsh codes, and the control channel **1202(i)** are encoded by Walsh codes with increasing indexes in relation to the increasing value of MAC IDs in block **1204**.   However, one of ordinary skills in the art appreciates that other relationships are within the scope of the invention.

[1092]   Consequently, a subscriber station may use ant determination method applicable for ordered set, e.g., one of the above-described methods.

[1093]   The control channel(s) structure in accordance with another embodiment is illustrated in **FIG. 13**. Each of the control channels **1302(i)** contains all the information a subscriber station needs to decode the F-PDCH. Therefore, in one embodiment, each of the channels **1302(i)** comprises a MAC ID block **1306(i)** identifying a subscriber station for which the channel **1302(i)** is intended, a partial MAC ID block **1308(i)** identifying subscriber stations for which another control channel **1302(i)** is intended, and information block **1310(i)**, enabling a subscriber station identified by the MAC ID of block **1306(i)** to demodulate the F-PDCH. In addition, one of the control channels **1302(i)**, e.g., a control channel **1302(1)** comprises a block **1304** identifying number of control channels **1302(i)**. The identification of partial MAC ID is an implementation issue. In one embodiment, the MAC ID is expressed as an 8-bit number. Therefore, a subset of the bits identifies a partial MAC ID. In one embodiment, the subset comprises the most significant bits of a MAC ID.

[1094]   To receive the control channels **1302(i)** the subscriber stations must know modulation parameters of the control channels **1302(i)**.   In one embodiment, the modulation parameters and the number of possible control channels are pre-determined.   In one embodiment, the modulation parameters

comprise different Walsh codes. However, one of ordinary skills in the art appreciates that other relationships are within the scope of the invention. Furthermore, there exists a relationship between the control channels **1302(2)-1302(m)** and the partial MAC IDs. The relationship is determined by a method the subscriber stations with MAC ID matching the partial MAC ID a control channel **1302(i)** use to select the next control channel **1302(i)** to demodulate. One of ordinary skills in the art appreciates that such a method, consequently, the relationships is an implementation issue. In accordance with one embodiment, the partial MAC ID from block **1308(i)** of channel **1302(i)** identifies a control channel **1302(m-i-1)**.

[1095]   Because all subscriber stations must reliably receive the control channel **1302(1)**, the control channel **1302(1)** is transmitted at power determined by power requirement of the subscriber station with the worst forward link quality metric. Because each of the control channel **1302(2)-1302(m)** is intended for one of the subscriber stations and the base station has an information about the subscriber station forward link quality metric, the base station transmits each of the channels **1308(i)** at the minimum power determined by power requirement of the subscriber station.

[1096]   In one embodiment, the channels **1302(i)** are transmitted concurrently, consequently, each of the subscriber stations accumulates data from all the channels **1202(i)**, and then post processes the accumulated data. During the post processing, each of the subscriber stations first demodulates the control channel **1202(1)** and decodes a MAC ID of block **1306(1)**. The subscriber station with MAC ID identical to the MAC ID of block **1306(1)** decodes the remaining information, and processes the sub-packet on the F-PDCH in accordance with the gathered information.

[1097]   If the block **1304** indicates that there are no additional control channels **1302(i)**, the determination method ends.

[1098]   If the block **1304** indicates that there are _m_ additional control channels **1118(i)**, the determination proceeds as follows.

[1099]   The subscriber stations with MAC ID matching the partial MAC ID of block **1108(1)** demodulate and decode the control channel **1302(m)**, to acquire the MAC ID of block **1306(m)**.   The subscriber station with MAC ID identical to the MAC ID of block **1306(m)** demodulates and decodes the remaining information of the control channel **1302(m)**, and processes the sub-packet on the F-PDCH in accordance to the gathered information.   The subscriber station with MAC ID not matching the MAC ID of block **1316(m)** demodulates the next control channel **1302(2)** as described below.   Since the subscriber station has already processed the control channel **1302(m)**, the subscriber station continuing processing and encountering control channel **1302(m)** can cease further processing.

[1100]   The subscriber stations with MAC ID not matching the partial MAC ID of block **1308(1)** demodulate the next control channel **1302(i)**, i.e., the control channel **1302(2)**.   The subscriber station with MAC ID identical to the MAC ID of block **1316(2)** decodes the remaining information of the control channel **1302(2)**, and processes the sub-packet on the F-PDCH in accordance to the gathered information.   The subscriber stations with MAC ID matching the partial MAC ID of block **1318(2)** follow the processing as outlined with respect to MAC ID in block **1308**.   (Thus, the subscriber stations demodulate and decode the control channel **1318(m-1)**, to acquire the MAC ID of block **1314(m-1)**).

[1101]   The method is repeated until the subscriber station exhaust all the control channels **1302(i)**, or finds a control channel **1302(i)** with MAC ID indicating that the control channel **1302(i)** is intended for the subscriber station.

Code Channel Assignment Signaling

[1102]   As discussed, the control channel structure of the invention may utilize the control channels of the 1xEV-DV proposal, according to the above-described embodiment.   Consequently, the control channel structure of the invention must preserve or improve the functionality of the control channels of the 1xEV-DV proposal.

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[1103]   In accordance to the 1xEV-DV proposal, the F-PDCH sub-packet de-multiplexed into a variable number of pairs (In-phase and Quadrature) of parallel streams, and each of the parallel streams is covered with a distinct 32-ary Walsh code. The F-PDCH Walsh codes are assigned from a Walsh Space List of 28 possible assignments, starting from the top of this list.

Table 1. Default F-PDCH Walsh Space List

32-ary Walsh Codes
31
15
23
7
27
11
19
3
29
13
21
5
25
9
30
14
22
6
26
10
18
2
28
12
20
4
24
8

[1104]   When using the F-PDCH the Walsh code assignment for the F-PPDCCH, F-SPDCCH, and the F-PDCH. Furthermore, for the F-PDCH, number of such codes and the Walsh assignments of such codes are required. The

number of Walsh codes in use for the F-PDCH is transmitted on the F-SPDCCH. A system and a method for signaling the Walsh space assignment is disclosed in co-pending application serial number 60/297,105 entitled "HANDLING THE WALSH SPACE INDICATOR FOR 1XEV-DV," filed June 7, 2001, and assigned to the assignee of the present invention.

[1105]   In accordance with one embodiment of the present invention, the Walsh space is assigned in accordance with a power of the F-SPDCCH. In one embodiment, the assignment starts with a highest power F-SPDCCH and the lowest Walsh space. Accordingly, the lowest portion of the Walsh space is assigned by the highest power F-SPDCCH, the next lower portion of the Walsh space is assigned by the second highest power F-PDCH, until all the F-SPDCCH are exhausted. To save power and capacity of the F-SPDCCH, instead of listing the individual Walsh code indexes, each in the F-SPDCCH comprises the number of Walsh codes used.

[1106]   For example, referring to Table 1, if the highest power F-SPDCCH assigns the Walsh space comprising the Walsh codes with indexes 31, 15, 23, 7, 27, and 11, the highest power F-SPDCCH comprises the number 6, which is the number of Walsh codes. Similarly, if the second highest power F-SPDCCH assigns the Walsh space comprising the Walsh codes with indexes 19, 3, 29, 13, 21, 5, 25, the second highest power F-SPDCCH comprises the number 6.

[1107]   The subscriber station processes the plurality of F-SPDCCHs in accordance with the above-disclosed embodiments, to obtain the number of Walsh codes from each of the plurality of the F-SPDCCHs. The subscriber station further measures power of each of the plurality of the F-SPDCCH, and orders the obtained numbers of Walsh codes with the measured power. Because the subscriber station is provided with the Walsh Space List, the subscriber station can associate each of the obtained number of Walsh codes with the Walsh codes.

[1108]   Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits,

symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[1109]   Those of skill would further appreciate that the various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

[1110]   The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[1111]   The steps of a method or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two.   A

software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor such the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

[1112]   The previous description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

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[1114]   **WHAT IS CLAIMED IS:**